Demystifying IoT skills

What does it take to become a FullStack IoT engineer?

Jayakumar Balasubramanian,
Emertxe, Bangalore

Agenda

- Overview of IoT Architecture

- Various skill "areas" in IoT

- Embedded Systems - Skill stack

- Embedded to IoT – Key changes

- Conclusion

- Q & A

We are an Education Company

Embedded Systems | IoT | FullStack Web Development

What problems we are solving?

- **Employability:** Fresh engineers with Immersive training programs

- **UpSkilling:** Organizations & Working professionals with custom training programs

60000+
Students trained
since inception

100+
Corporate Training
companies

366+
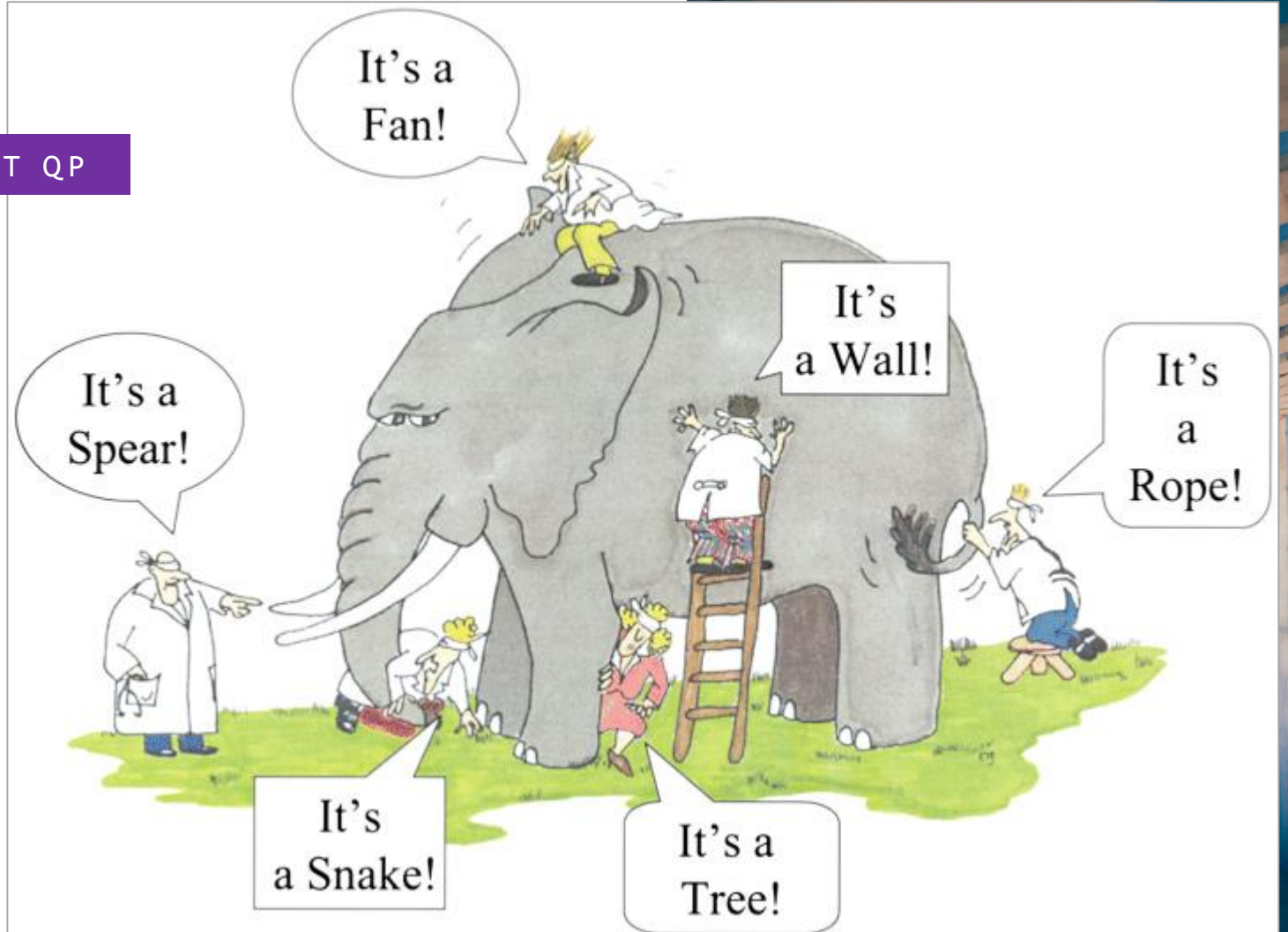Placement
companies for hiring

50+
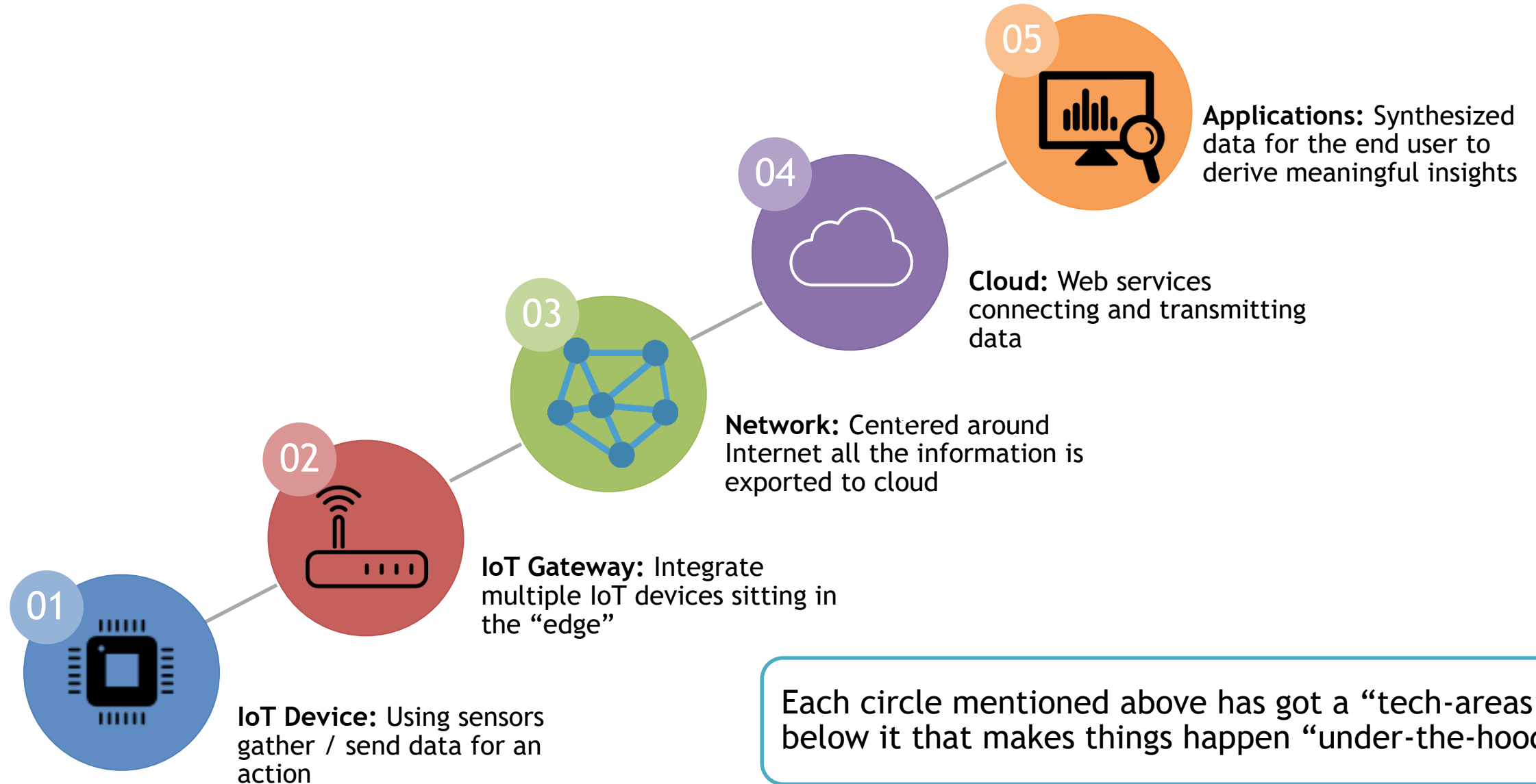Customized Training
programs

NSDC | ESSCI | IoT QP

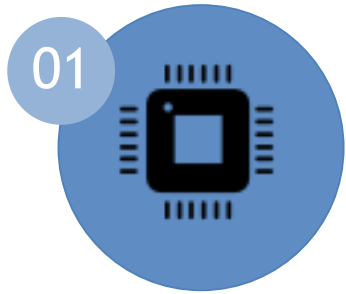# The six blind men and IoT during team discussion

We were a bunch of folks trying to review IoT QP and NoS in our own ways. It had everything from sensors to Android application programming.

IoT Architecture

Applications: Synthesized data for the end user to derive meaningful insights

05

04

Cloud: Web services connecting and transmitting data

03

Network: Centered around Internet all the information is exported to cloud

02

IoT Gateway: Integrate multiple IoT devices sitting in the "edge"

01

IoT Device: Using sensors gather / send data for an action

Each circle mentioned above has got a "tech-areas" below it that makes things happen "under-the-hood"
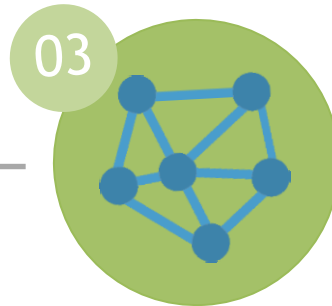
IoT Tech Areas

IoT Device:

- Programming
- Controllers
- Sensors
- Actuators
- Interfacing
- Optimization
- Protocols

IoT Gateway:

- Programming
- OS / EOS / RTOS
- Protocols
- Edge computing

Network:

- Lightweight
- Scalable
- Data formats
- QoS

Cloud:

- Platform
- Web services
- Scalability
- Distributed
- BI / Analytics
- Cost optimization

Applications:

- UX / UI
- Mobile / Web Application
- Presentation

Add-on: Many vendors / platforms, security, technology choices (include OpenSource), standards

Some Questions!

Given the depth and breadth of IoT, some obvious questions pops up in every engineer's mind!

Isn't it unfair?

Given the depth and breadth of IoT technologies, having one engineer to become an expert is possible?

Where to start?

Where to start? What to focus? What would be the tangible outcome of learning?

How long would it take?

How long an engineer would take to understand the "other" side of the technology?

Engineer mindset

Shifting an engineer's mindset (ex: Embedded Engineer -> Data Scientist)

IoT show.in

WhiteBox or BlackBox?

Configure & Integrate IoT cloud

FullStack Application
IoT developer's view

05 Applications

04 Cloud

03 Network

02 IoT Gateway

01 IoT Device

Design & Program Embedded IoT

FullStack Embedded
IoT developer's view

WhiteBox or BlackBox?

Configure & Integrate IoT cloud

FullStack Application IoT developer's view

05 Applications

04 Cloud

03 Network

02 IoT Gateway

01 IoT Device

Design & Program Embedded IoT

FullStack Embedded IoT developer's view

Proposed Approach to Skill Building

Get-Exposure: Know about Sensor / Device / Network / Cloud / Applications

Get-Hands-On with one or max two tech stacks

Embedded – IoT Stack

- **Programming Languages:**
  - C Programming
  - Python programming

- **IoT Device and Gateway:**
  - MC programming (using Arduino)
  - Gateway programming (using R-Pi)

- **IoT Domain specific:**
  - IoT Architecture
  - Setting up IoT workflows
  - IoT protocols
  - IoT cloud infrastructure
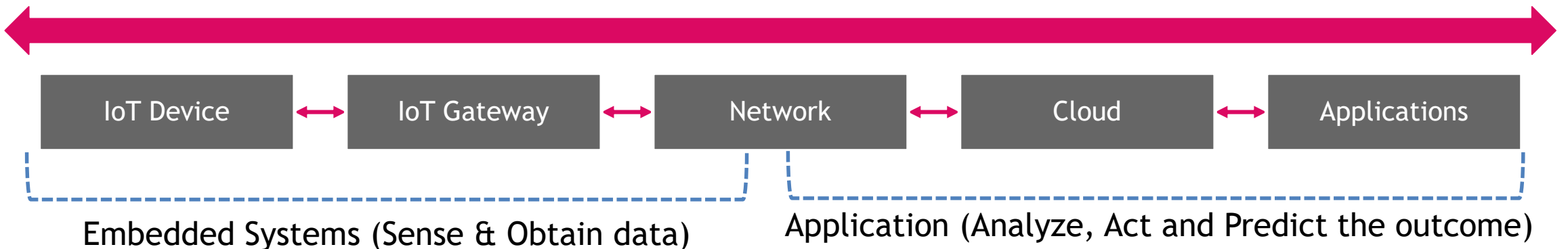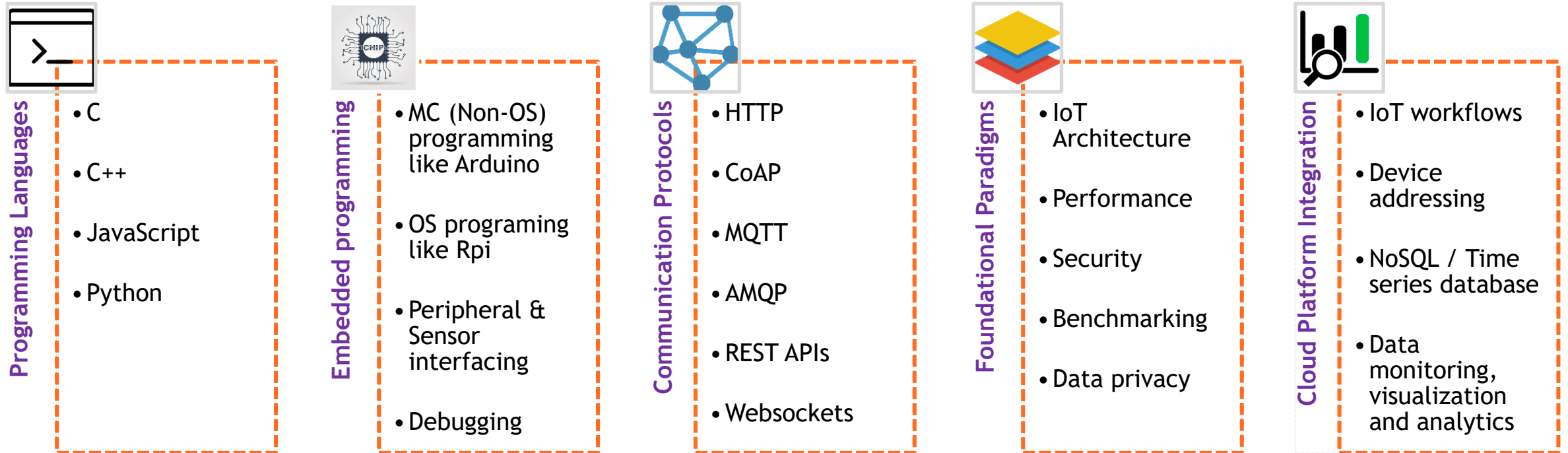 - Performance and security in IoT

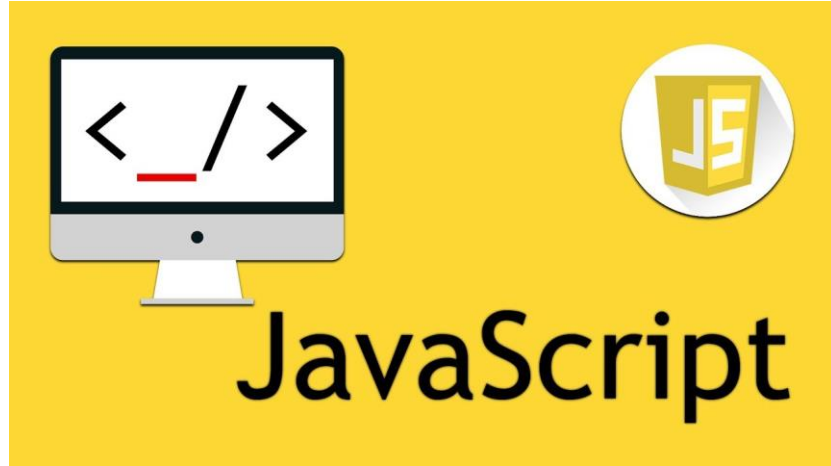## Capabilities / Tangible Outcomes

- Design and program IoT device and gateway

- Hardware interfacing

- Optimization

- Making right protocol choice

- Making right IoT platform choice

- IoT cloud and integration skills

- IDE / Development tools

Embedded IoT Skills

Programming Languages
- C
- C++
- JavaScript
- Python

Embedded programming
- MC (Non-OS) programming like Arduino
- OS programing like Rpi
- Peripheral & Sensor interfacing
- Debugging

Communication Protocols
- HTTP
- CoAP
- MQTT
- AMQP
- REST APIs
- Websockets

Foundational Paradigms
- IoT Architecture
- Performance
- Security
- Benchmarking
- Data privacy

Cloud Platform Integration
- IoT workflows
- Device addressing
- NoSQL / Time series database
- Data monitoring, visualization and analytics

IoT Device	↔	IoT Gateway	↔	Network	↔	Cloud	↔	Applications

Embedded Systems (Sense & Obtain data)

Application (Analyze, Act and Predict the outcome)

Embedded to IoT changes

#1 JavaScript everywhere

- Traditional Embedded System developers used C / C++ as the primary programming language over the years

- Its mainly because of some unique advantages (Optimal machine code, hardware access, memory management etc..)

- JavaScript is making foray into IoT development with frameworks like Cylon.js (JavaScript framework for robotics, physical computing and IoT)

- It makes it easy to learn and program and leverage excellent libraries.

- Embedded Systems developers need to transition with one scripting language, preferably JavaScript / Python for programming IoT

Embedded to IoT changes
#2 The "Things" OS

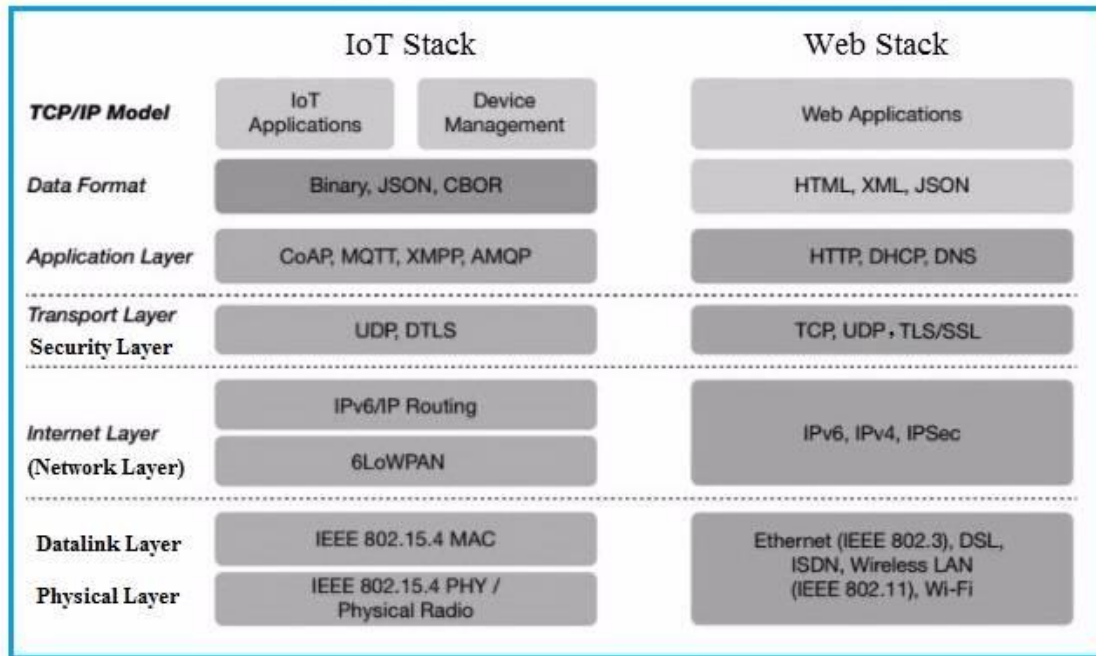Amazon FreeRTOS

arm MBED

MONGOOSE OS

android things

- Traditional Embedded System developers used bare metal programming (For controllers) and OpenSource Linux (For processors)

- This required quite a lot of programming and customization efforts from the development engineer

- Thanks to the growth of IoT, major popular players are investing heavily in OpenSource based highly customizable and easy to use IoT OS

- These OS have pre-built in features that are essential for IoT (ex: security, device protocols, library support etc…)

- This makes development faster and easier (as much as 90%!!)

IoT show.in

	IoT Stack		Web Stack
TCP/IP Model	IoT Applications	Device Management	Web Applications
Data Format	Binary, JSON, CBOR		HTML, XML, JSON
Application Layer	CoAP, MQTT, XMPP, AMQP		HTTP, DHCP, DNS
Transport Layer / Security Layer	UDP, DTLS		TCP, UDP, TLS/SSL
Internet Layer (Network Layer)	IPv6/IP Routing		IPv6, IPv4, IPSec
	6LoWPAN		
Datalink Layer	IEEE 802.15.4 MAC		Ethernet (IEEE 802.3), DSL, ISDN, Wireless LAN (IEEE 802.11), Wi-Fi
Physical Layer	IEEE 802.15.4 PHY / Physical Radio		

- Traditional Embedded Systems developers obtained networking and protocols skills only if they are involved in that area of work

- In case of IoT it is an essential skill, where common protocols and data formats knowledge is very important for a developer

  - REST APIs
  - JSON / CBOR
  - Asynchronous programming
  - Web Sockets

- Between IoT device and gateway much more protocol choices are available. From IoT device to cloud choices are relatively limited (ex: MQTT)

- Choosing right set of protocols for the given IoT use case is one important skill that Embedded IoT engineer should posses

Embedded to IoT changes

#4 Qt framework

- In order to get meaningful insights the IoT UI / Dashboard plays a very important role

- At times rich UI is required as a part of Embedded devices (ex: Automotive / Medical / Industrial) in form of user dashboards

- Qt has emerged as a light-weight, platform independent framework which can be used for developing IoT UI

- Communication between devices is at the heart of the IoT. Qt APIs makes it easy to use

- It enables IoT devices to interact with new wireless technologies and the cloud via Bluetooth, NFC, Websockets and more

Embedded to IoT changes
#5 Foundations are here to stay!

- Irrespective of new technologies, foundations are here to stay in Embedded side of IoT

- Efficient Algorithms, Design, OOP, Optimization

- Choosing right data structure

- Optimal resource usage Memory management

- Asynchronous handling

- Interfacing

Conclusion

- IoT is a big paradigm that brings multiple technology areas together

- It would be unfair to build expertise in both depth and breadth of all areas

- Our recommendation is to take a 'T' model by balancing horizontal exposure and vertical hands-on experience

- For an Embedded developer transitioning into IoT requires adapting to some of the changes. These changes are aimed to make the development process easier and faster

- Irrespective of all changes, foundation skills play very important role!

Our co-ordinates

Jayakumar Balasubramanian: b.jayakumar@emertxe.com

Emertxe Information Technologies,
#83 Farah Towers,
1st Floor,
MG Road,
Bangalore - 560001

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Q & A